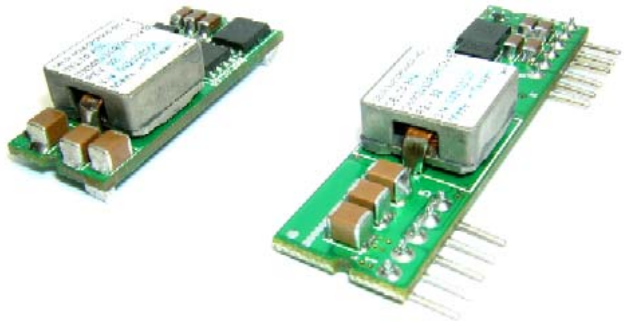
DNM, DNL SIP Series

Evaluation Procedure (DEP-001 A)

The Delphi DNM and DNL Series of SIP type POL converters

The DNM and DNL, 2.4~5.5V or 10~14V input, programmable output, non-isolated point of load DC/DC converters, are the latest offering from one of the world's largest power supply manufacturers — Delta Electronics, Inc. The DNM and DNL product family also has a flexible, programmable tracking feature, which provides a variety of startup voltages as well as sequencing and tracking between power modules. With creative design technology and optimization of component placement, these converters possess outstanding electrical and thermal performance, as well as extremely high reliability under highly stressful operating conditions. All models possess a myriad of standard protection features.

This document guides the user through the evaluation procedures to qualify a POL module. The data shown in this Evaluation Procedure is for the SIP Package Type POL evaluation board. Please refer to the data sheet for detailed performance and technical information for the specific POL units.



1.0 Purpose

This document guides the user in performing electronic measurements on a DNM and DNL POL (point of load) DC/DC converter by using the Delta Evaluation Board.

2.0 Relevant Documentation

The documentation and background information listed below is relevant to this evaluation procedure:

2.1 Appropriate date sheet for the DNM or DNL Series units.
2.2 Power Module Evaluation Board Schematic.
2.3 Power Module Evaluation Board Layout.
2.4 General Test and Safety Procedures.

3.0 Equipment Required

3.1 A DC Power Supply 0 - 20 V @ 0 - 20A (Agilent 6574A 0 -60V/0 - 35A or equivalent).

3.2 An oscilloscope (Tektronix TDS 3034 or equivalent) 4 Channel 300 MHz, equipped with a x1 scope probe, a x10 scope probe, and two BNC cables (length less than 20 inches/500mm)

3.3 Digital multi-meters, one with 20A range and ideally all with 4 1/2 digit resolution (DVM1, DVM2 and DVM3) (Zentech 2041 or equivalent).

3.4 An electronic load (Chroma 63030 or equivalent), 300W approximate rating, or a suitable resistive load.

3.5 A DC power supply (GW GPC-3060D).

4.0 Equipment Set-Up and Description

Refer to the Power Module Evaluation Board Layout (See page 19) for reference designators cited in this document and Figure 1. Set-up Diagram.

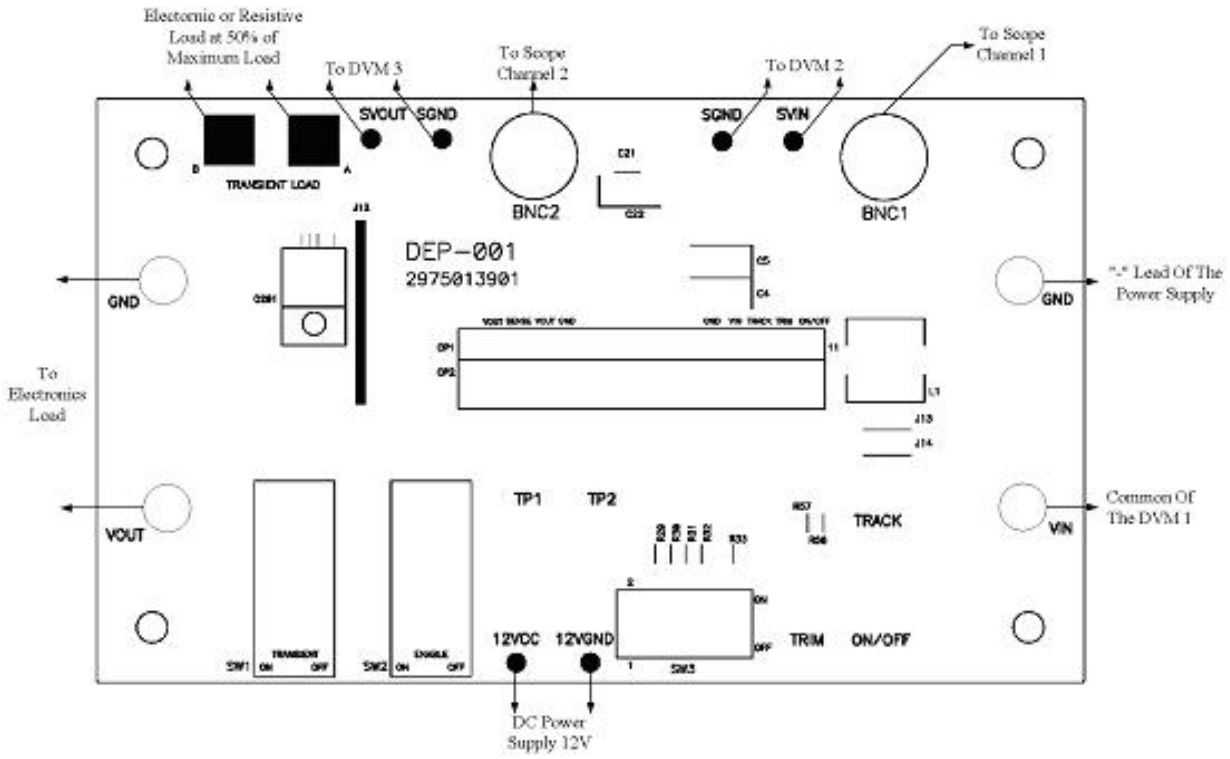


Figure 1. Set-up Diagram

4.1 Connect one lead from the “+” lead of the DC source (See Item 3.1) to the “20A” terminal of the first multi-meter DVM1 (See Item 3.3). Then connect one lead from the “Common” of the DVM1 to the “Vin” pin of the Evaluation Board. DVM1 is used to measure the input current.

4.2 Connect one wire from the “-” lead of the DC source (See Item 3.1) to the “GND“ pin of the Evaluation Board. Note: Use stranded leads at least equivalent to 14 AWG for all connections in sections 4.1 and 4.2. The leads should be twisted to reduce noise coupling.

4.3 Connect the plus “+” and minus “-“ connection leads from a second multi-meter (See Item 3.3) to the “SVin” and “SGND” pins on the Evaluation Board. This multi-meter is designated DVM2. DVM2 is used to measure the input voltage.

4.4 Connect the plus “+” and minus “-“ connection leads from the third multi-meter (See Item 3.3) to the “SVOUT” and “SGND” Pin on the Evaluation Board. The multi-meter is designated DVM3. DVM3 is used to measure the output voltage.

4.5 Connect a BNC cable (length less than 20 inches/500mm) from BNC1 of the Evaluation Board to Channel 1 of the oscilloscope (See Item 3.2). This cable is used to measure the input voltage (between SVIN and SGND).

4.6 Connect a BNC cable (length less than 20 inches/500mm) from BNC2 of the Evaluation Board to Channel 2 of the oscilloscope (See Item 3.2). This cable is used to measure the output voltage (between SVOUT and SGND).

4.7 Connect the positive and negative power leads of the electronic load (ensuring correct polarity), or an appropriate resistive load to the Evaluation Board output terminal pin (“Vout” for positive power lead and “SGND” for the negative power lead).

4.8 Connect one lead from the “+” lead of the DC source (See Item 3.5) to the “12Vcc” on the Evaluation Board. Then connect one lead from the “-” of the DC source (See Item 3.5) to the “12VGND” on the Evaluation Board.

5.0 Thermal Management of the Converter

It is imperative that sufficient airflow needs to be provided to the converter at all times during all portions of testing. Please refer to the applicable data sheet for the proper cooling and derating necessary conditions to obtain accurate results when testing the converter.

6.0 Tests Performed

The following tests are performed at room temperature (+25 ℃).

6.1 Input Characteristics

- Input Voltage Range.
- Under-Voltage Lockout.
- No Load Input Current.

6.2 Output Characteristics

- Line Regulation.
- Load Regulation.
- Output Regulation.
- Output Voltage Set-point Programming
- Output Voltage Margining
- Output Voltage Tracking

6.3 Dynamic Characteristics

- Maximum Output Voltage Deviation (due to step change in load).
- Turn on Response time.

6.4 Thermal Characteristic

- Efficiency

7.0 Test Set-Up

7.1 Initial Set-Up

1) Examine the part number of the power module to determine that the correct module is being evaluated. Note: DNM04S0A0**S**10P A would denote the SMT package, while DNM04S0A0**R**10P A would denote the SIP package. This Evaluation Board is for SIP package.

2) Set the multi-meter DVM1 to the DC current 20A range. Set multi-meters DVM2 and DVM3 to DC voltage, auto ranging.

3) Electronic Load
Turn on the Electronic Load at CR mode (or resistive load) and adjust the current level. The maximum rated output current is **10A** for the model **DNM** series and **16A** for the **DNL** series. Ensure the output load does not exceed the recommended maximum current.

4) SW1 is used for on/off Transient function test. Turn SW1 to the OFF position if this function is not being used. Turn SW1 to the ON position if the Transient function test is required.

5) SW2 is used to enable or disable the converter.
For **positive** logic module, When SW2 is pose for the ON position, the converter is ON, and SW2 is pose for the OFF position, the converter is OFF.
For **negative** logic module, When SW2 is pose for the ON position, the converter is OFF, and SW2 is pose for the OFF position, the converter is ON.

6) SW3 is used for the Output Voltage Set-Point Adjustment Range.
By an external voltage source:
If the converter requires a trim up, put the **SW3_1** to ON position.
If the converter requires a trim down, put the **SW3_2** to ON position.
By an external resistor:
If the converter requires a trim up to Vo,set, put the **SW3_8** to ON position.
If the converter requires a margin trim down, put the **SW3_3** to ON position.
If the converter requires a margin trim up, put the **SW3_4** to ON position.
The SW3 Function table is listed as follows:

SW3 Function table

Subdivide switch NO.	Obligation
SW3_1	Voltage trim up
SW3_2	Voltage trim down
SW3_3	Resistor margin trim down
SW3_4	Resistor margin trim up
SW3_8	Resistor trim up

Note:
1. The subdivide switch of SW3_1~4 must not be **ON** at the same time.
2. For the SW3_5~7 use at NPA series, so must push to OFF position.

7.2 Initial Power Up

1) Turn the power supply ON, set the current limit on DC source (refer to specification of either converter) and increase the input voltage (use DVM2 to monitor the input voltage) until it reaches the desired value.
2) Set the switch SW2 to power module ON.
3) The converter is now operating, which can be verified by observing the DVM3 (appropriate value for the nominal output voltage) and channel 2 of the oscilloscope (appropriate value for the nominal output voltage).
4) Set the switch SW2 to power module OFF.

8.0 Tests and Evaluation

8.1 Input Characteristics

8.1.1 Input Voltage Range and Under-Voltage Lockout

The DNM04xx and DNL04xx Series of DC/DC converters will operate at full load from 2.4Vin to 5.5Vin for 5Vin (nominal) types. The DNM12xx and DNL12xx Series DC/DC converters will operate at full load from 10Vin to 14Vin for 12Vin (nominal) types. The converters feature input under-voltage protection, which will not allow the converter to start up unless the input voltage exceeds the turn-on voltage threshold.

Test

1) Turn on the fan.
2) Set the input voltage to the desired operating point while monitoring DVM2.
3) Set the switch SW2 to the “ON or OFF” position to enable the converter. (See Item 7.1.5)
4) Test the input under voltage function while observing DVM2, DVM3 and channel 1 of the oscilloscope. Increase the input voltage until the output of the converter reaches the appropriate value. This will occur between 2.05 and 2.25 volts for 5Vin nominal and between 9.0 to 10 volts for 12Vin nominal. Please refer to the appropriate converter data sheet for the detailed specification.

8.1.2 No Load Input Current Test

1) Turn on the fan.
2) Set the input voltage to the desired operating point while monitoring DVM2.
3) Set the switch SW2 to the converter ON.
4) Remove/disable the output electronic load or resistive load.
5) Note the input current from DVM1.
6) The result is the No-Load Input current of the DC/DC converter.
   The No-Load Input Current will be around 50 to 150 mA depending on the model under evaluation. (Please refer to the data sheet for the detailed specification).

8.2 Output Characteristics

8.2.1 Line Regulation

Line Regulation Deviation is defined as the change in output voltage caused by varying the input voltage over a specified range while the output load and temperature remain constant.

Test

1) Turn on the fan.
2) Set the output power to the desired operating point.
3) Set the switch SW2 to the converter ON.
4) Adjust the input voltage across the converter's input range (refer to specified range) while monitoring DVM2.
5) Note the maximum +/- deviation of the output voltage over the full range of the input operating voltage (please refer to the data sheet for the detailed specification).

8.2.2 Load Regulation

Load Regulation Deviation is defined as the change in output voltage caused by varying the output load current over the specified range (no load to full load) while the input voltage and temperature remain constant.

Test

1) Turn on the fan.
2) Set the input voltage to the desired operating level while monitoring DVM2.
3) Set the switch SW2 to the converter ON.
4) Adjust the output load across the converter's operating load range.
5) Note the maximum +/- deviation of the output voltage over the full range of the operating load range (please refer to the data sheet for the detailed specification).

8.2.3 Output Ripple

Output Ripple is defined as the periodic AC component on the DC/DC converter's output voltage. The output ripple is measured in terms of peak to peak and RMS values, both done with a specific bandwidth.

Test

1) Turn on the fan.
2) Set the switch SW2 to the converter ON.
3) Adjust the input voltage while monitoring DVM2 and set the output load to the full rated load current.
4) Adjust channel 2 on the oscilloscope to be AC coupled at 4µS/Div and at 10mV/Div using the 20 MHz bandwidth-limit option on the scope.
5) The output ripple of the DC/DC converter is measured at full load operating power.

8.2.4 Output Voltage Set-point Programming

(1) Output Voltage Set-Point Adjustment by external resistor

Output Voltage Set-point Programming can be carried out by using the external program resistor connect between TRIM pin to ground to set output voltage set-point from 0.75Vdc to 5Vdc, the location can refer to the Evaluation Board Schematic (please refer to the data sheet for more the detailed specification). These test functions are divided into two types,

Rset of DNM04S and DNL04S series can be calculated by using the following equation:

$$R_{set} = \left[\frac{21070}{Vo - 0.7525} - 5110 \right] \quad \Omega$$

For example, to program the output voltage of the DNL04 module to 1.8Vdc, below is the calculation of Rtrim:

$$R_{set} = \left[\frac{21070}{1.8 - 0.7525} - 5110 \right] = 15004 \quad \Omega$$

The table 1 provides the Rset value required for some standard output and the location on the Evaluation board is R33.

Table 1.

Vo,set	Rset (kΩ) R33	Recommend Value, R//R
0.7525	Open	Open
1.2	41.973	44.2k//825k
1.5	23.077	23.7k//825k
1.8	15.004	15.4k//590k
2.5	6.947	7.15k//243k
3.3	3.160	3.16k//Open

Rset of the DNM12S and DNL12S series can be calculated by using the following equation:

$$R_{set} = \left[\frac{10500}{Vo - 0.7525} - 1000 \right] \quad \Omega$$

For example, to program the output voltage of the DNL12 module to 3.3Vdc, below is the calculation of Rset:

$$R_{set} = \left[\frac{10500}{3.3 - 0.7525} - 1000 \right] = 3122 \ \Omega$$

The table 2 provides the Rset value required for some standard output. The location on the Evaluation board is R33.

Table 2.

Vo,set	Rset (kΩ) R33	Recommend Value, R//R
0.7525	Open	Open
1.2	22.464	23.7k//432k
1.5	13.047	14.0k//191k
1.8	9.024	9.53k//169k
2.5	5.009	5.23k//118k
3.3	3.122	3.16k//261k
5.0	1.472	1.5k//78.7k

Test

1. Put the resistor to program the desired output voltage set point by follow Table 1 and Table 2 for the standard output.
2. Set the input voltage to the desired operating level while monitoring DVM2.
3. Turn on the fan.
4. Set the enable switch SW2 to the “ON” position to enable the converter.
5. Adjust the output load across the converter’s operating load range.
6. Note the output voltage over the full range of the operating load range (please refer to the data sheet for the detailed specification).

(2) Output Voltage Set-Point Adjustment by external voltage source

For DNM and DNL series, trim to Vo,set using an external voltage source, connect it between the TRIM pin and GND pin. Please refer to the **Table 3** and **Table 4** as below for the appropriate Vout. The value of Vtrim is specified as follows:

For DNM04xx and DNL04xx series

$$Vtrim = 0.7 - 0.1698 \times (Vout - 0.7525)$$

For example, to program the output voltage of a DNL04 module to 3.3 Vdc, Vtrim is calculated as follows:

$$Vtrim = 0.7 - 0.1698 \times (3.3 - 0.7525) = 0.267V$$

Table 3. : Vo,set adjustment range using external voltage source.

Product Part	Normal Output Set Voltage (Vdc)	Vrim (V)
DNM04S0A0R10P A/B/C DNM04S0A0R10N A/B/C DNL04S0A0R16P A/B/C DNL04S0A0R16N A/B/C	0.7525	Open
	1.2	0.6240
	1.5	0.5730
	1.8	0.5220
	2.5	0.4030
	3.3	0.2670

For DNM12xx and DNL12xx series

$$Vtrim = 0.7 - 0.0667 \times (Vout - 0.7525) \text{ V}$$

For example, to program the output voltage of a DNL12 module to 3.3 Vdc, Vtrim is calculated as follows:

$$Vtrim = 0.7 - 0.0667 \times (3.3 - 0.7525) = 0.53 \text{ V}$$

Table 4. : Vo,set adjustment range using external voltage source.

Product Part	Normal Output Set Voltage (Vdc)	Vrim (V)
DNM12S0A0R10P A/B/C DNM12S0A0R10N A/B/C DNL12S0A0R16P A/B/C DNL12S0A0R16N A/B/C	0.7525	Open
	1.2	0.670
	1.5	0.650
	1.8	0.630
	2.5	0.583
	3.3	0.530
	5.0	0.4167

8.2.5 Voltage Margining

Output voltage margining can be carry out by connecting a resistor from the Trim pin to ground pin for trim up and connecting a resistor from Trim pin to Output pin for Trim down. The Rmargin-up is for trim up and Rmargin-down is for trim down. (Please refer to the data sheet and Evaluation Board Schematic for the detailed information).

A software tool for voltage margining calculation is available to ask for. The values of Rmargin-up and Rmargin-down for a specific output voltage and margin percentage can then be figured out. Please consult your local Delta Field Application Engineer or sales persons for additional information.

Test

1) Put the resistor with desire of the voltage trim.
2) Turn on the fan.
3) Adjust the input voltage while monitoring DVM2 and with output load set to the desired operating point.
4) Set the enable switch SW2 to the “ON” position to enable converter.
5) Use SW3 (refer to Item 7.1_6) for Trim setup.
6) Note the voltage by observing DVM3.
7) Test the Load Regulation (refer to Item 8.2.2).

8.2.6 Voltage Tracking

The DNM/DNL family was designed for applications that have output voltage tracking requirements during power-up and power-down. The devices have a TRACK pin to implement three types of tracking method: sequential, ratio-metric and simultaneous. TRACK simplifies the task of supply voltage tracking in a power system by enabling modules to track each other, or any external voltage, during power-up and power-down.

By connecting multiple modules together, customers can get multiple modules to track their output voltages to the voltage applied on the TRACK pin.

Detailed Description

Sequential Implementation

Sequential start-up is implemented by connecting the power good signal (PWRGD pin) of PS1 to the TRACK pin of PS2 with a resistor–capacitor (RC) circuit. The power up and down that waveforms in Figures 4 and 5. In Figure 4, the 5V PS1 supply ramps up first. When supply reaches its final 5V steady state value, the open collector output of the PWRGD pin releases to the TRACK pin and the PS2 output voltage rises at the rate of the RC time constant. In Figure 5, the PWRGD pin pull low by PS1 ENABLE off or the PS1 output voltage is below 90% of the desired regulated voltage. The TRACK pin is pulled low and the PS2 power down. Figure 3 shows the circuit diagram of sequential start-up when Vo_{PS2} tracks the PWRGD of PS1.

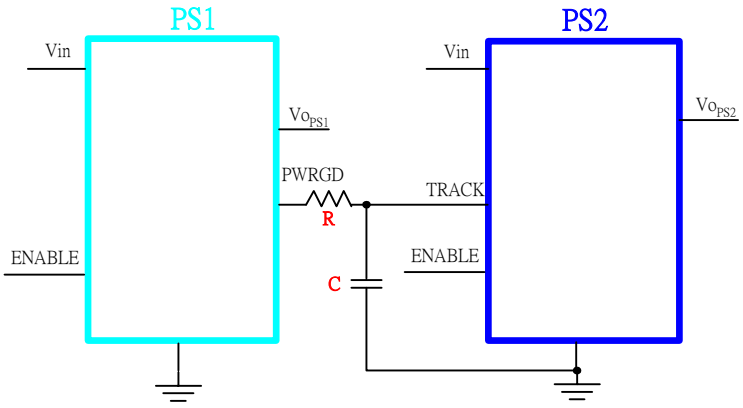


Figure 3. PS1 and PS2 track output voltage Sequential start-up

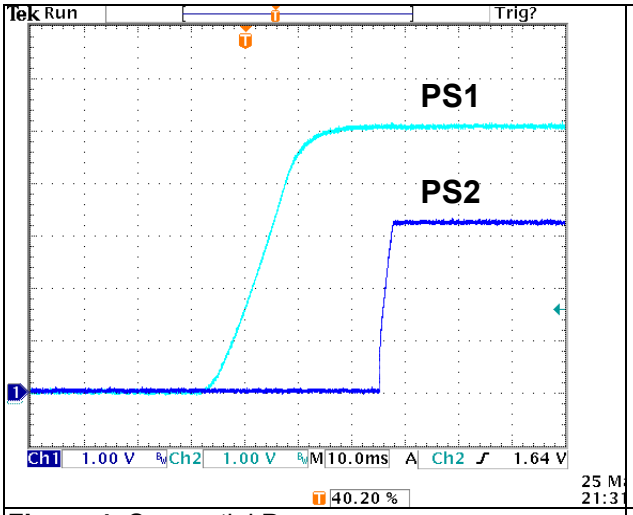


Figure 4: Sequential Power up

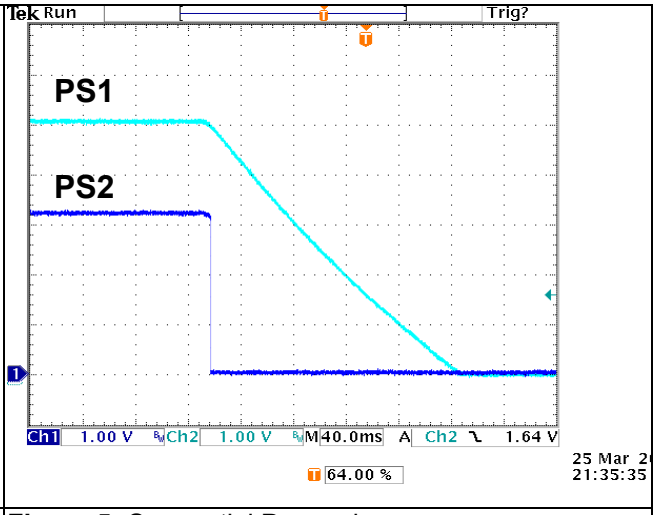


Figure 5: Sequential Power down

Ratio-Metric Implementation

Ratio–metric is implemented by the selection of the resistor values of the voltage divider on the TRACK pin. Resistors R1 and R2, in Figure 6 determine the tracking method that is implemented.

To simplify the tracking design, R2 initial set value equal 20KΩ at internal circuit and only set one resistor R1 for different tracking method. Figure 6 shows the circuit diagram of Ratio-Metric start-up when Vo_{PS2} tracks the Vo_{PS1}.

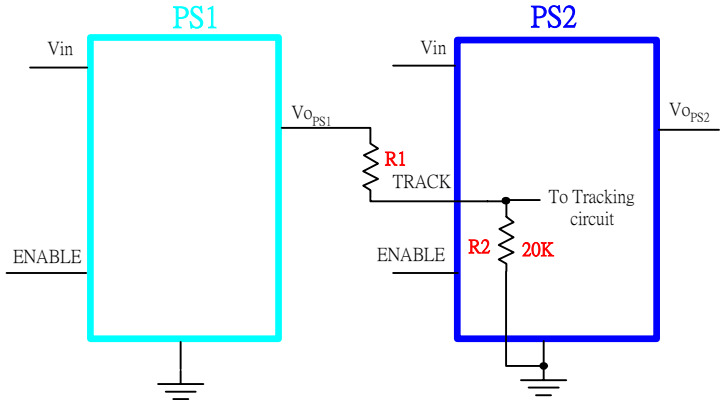


Figure 6. PS1 and PS2 track output voltage Ratio-Metric start-up

For Ratio-Metric applications that need the PS1 and PS2 outputs arrive regulation set point at same time, use equation 1 to calculate R1, set △V=$Vo_{set,PS1}$–$Vo_{set,PS2}$ and △V will be negative. The waveforms of power up and down are showed in Figures 7 and 8.

$$R1 = \frac{[(Vo_{set,PS2} + \Delta V) - Vref]}{Vref} * 20K\ \Omega \text{ ----------(1)}$$

Note:

1. Vref =0.4×$Vo_{set,PS2}$, please refer to Table 5 for Vref set value.
2. △V is the maximum difference of voltage between PS1 and PS2 supply voltage.

For example, the PS1 $Vo_{set,PS1}$=5V, the PS2 $Vo_{set,PS2}$=3.3V, R1 is calculated as follows:

$$R1 = \frac{[(3.3+1.7)-1.32]}{1.32} * 20K = 55.75K\ \Omega$$

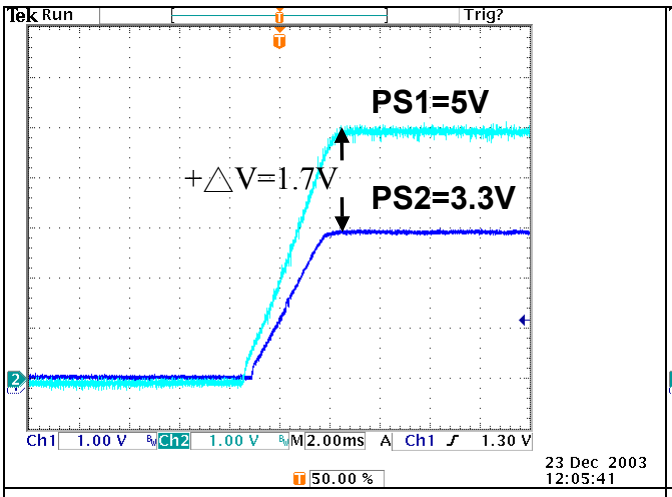


Figure 7. Ratio–metric tracking Power up

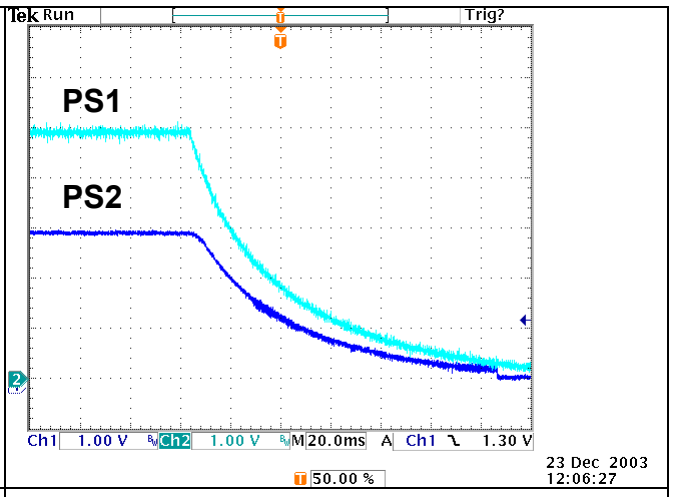


Figure 8. Ratio–metric tracking Power down

For Ratio-Metric applications that need the PS2 supply voltage rises first at power up and falls second at power down, use equation 2 to calculate R1, set △V≦0.4×$Vo_{set,PS2}$ and △V will be negative. The waveforms of power up and down are showed in Figures 9 and 10.

$$R1 = \frac{[(Vo_{set,ps2} - \Delta V) - Vref]}{Vref} * 20K \text{ ----------(2)}$$

Note:

1. Vref =0.4×$Vo_{set,PS2}$, please refer to Table 5 for Vref set value.
2. △V is defined as the voltage difference between Vo_{PS1} and Vo_{PS2} when Vo_{PS2} reaches its rated voltage.

For example, the PS1 $Vo_{set,PS1}$=5V, the PS2 $Vo_{set,PS2}$=3.3V, R1 is calculated as follows:

$$R1 = \frac{[(3.3-1.3)-1.32]}{1.32} * 20K = 10.303K \ \ \Omega$$

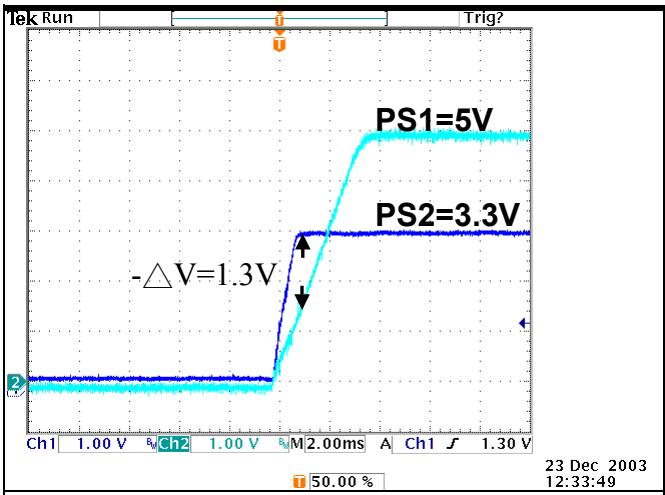


Figure 9. Ratio–metric tracking Power up

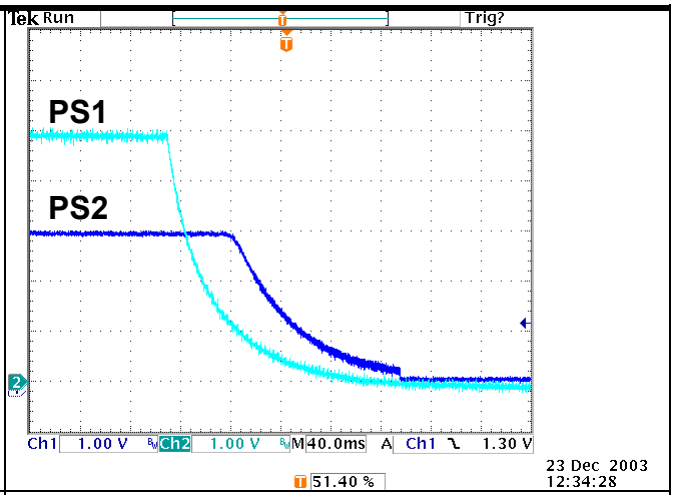


Figure 10. Ratio–metric tracking Power down

Simultaneous Implementation

Similar to the ratio-metric implementation, simultaneous tracking is implemented using a voltage divider on the TRACK pin. The objective is to minimize the voltage difference between the power supply outputs during power up and down. The waveforms of power up and down are showed in Figures 13 and 14.

For type A (DNXXX0A0XXXX **A**), the simultaneous tracking can be accomplished by connecting Vo_{PS1} of PS1 to the TRACK pin of PS2. Figure 11 shows the circuit diagram of voltage Simultaneous start-up when Vo_{PS2} tracks Vo_{PS1} (only for type A).

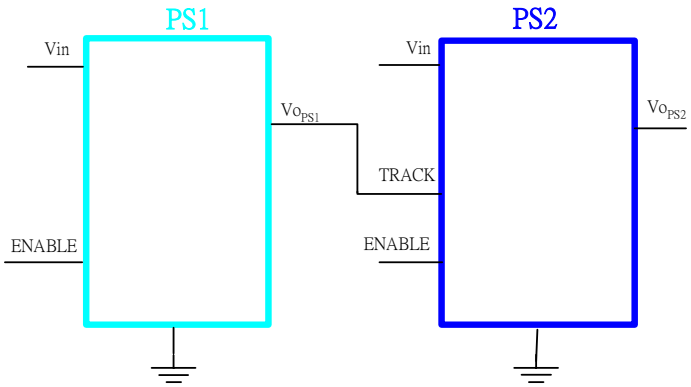


Figure 11. PS1 and PS2 track output voltage Simultaneous start-up for type A

For type C (DNXXX0A0XXXX **C**), the simultaneous tracking can be accomplished by putting R1 equal to 30.1KΩ through Vo_{PS1} to the TRACK pin of PS2. Figure 12 shows the circuit diagram of Simultaneous start-up when Vo_{PS2} tracks the Vo_{PS1} (only for type C).

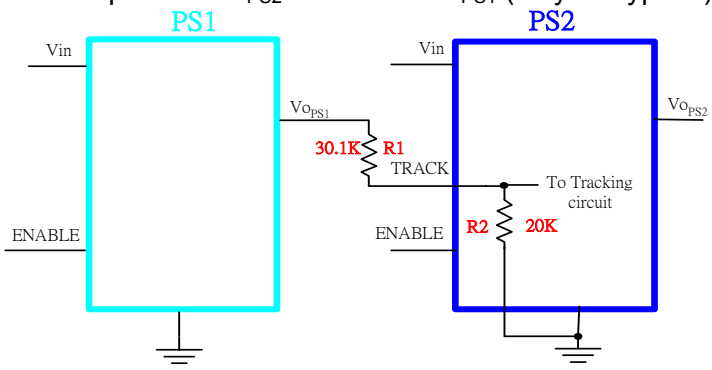


Figure 12. PS1 and PS2 track output voltage Simultaneous start-up for type C

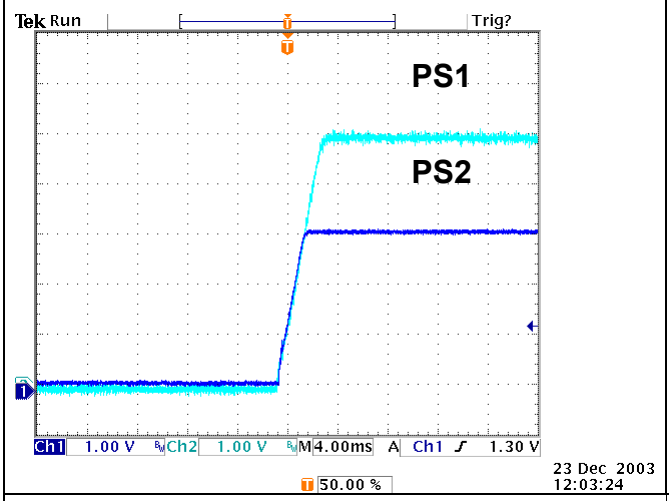


Figure 13. Simultaneous Power up

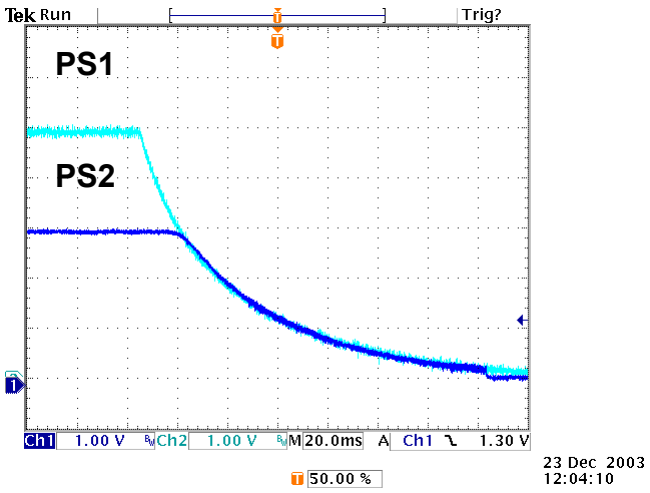


Figure 14. Simultaneous Power down

Table 5. : Vref definition

Voset,ps2	*Vref*
0.7525	0.3
1.2	0.48
1.5	0.6
1.8	0.72
2.5	1.0
3.3	1.32
5.0	2.0

Notes on the use of Track function:

1. For proper voltage tracking, first, The ENABLE On/Off pin of the PS2 module is left unconnected (or tied to GND for negative logic modules or tied to VIN for positive logic modules), so that the modules are ON by default and second applied input voltage to the PS1 and PS2. The TRACK pin is held at ground potential for duration of input voltage reaches its minimum input voltage (VIN,min) and then held for at least 10mS thereafter. This brief period gives the modules time to complete their internal soft-start initialization.

2. The PS2 output will not follow the PS1 voltage until the PS2 has completed its soft-start time. After this time, PS2 is capable of both sinking and sourcing current when following the voltage at the TRACK pin.

3. Notice that power down by removing the input voltage may not provide proper power tracking below under voltage lockout limit where the both integrated switches are off. So, using the ENABLE On/Off signal of PS1 for power down is the preferred option for power tracking.

4. The TRACK pin absolute maximum voltage cannot over the Vin.

5. For type A: When Tracking is unused, put R1 equal to 1KΩ and connect TRACK pin to +Vcc
   For type C: When Tracking is unused, put R1 equal to 30.1KΩ and connect TRACK pin to +Vcc

Test

1) Put R56 to take the place of R1 on the POL evaluation board by use the value from above equation for different tracking purpose.
2) Use channel 1 and channel 2 measures the output voltage of PS1 and PS2.
3) Prepare turn on, disable remote On/Off of the PS1, enable remote On/off of the PS2, and supply input voltage to PS1 and PS2.
4) For the power on, enable switch on of PS1. In the meantime, to track power up by scope trigger function.
5) For the power down, enable switch off of PS1 to track power down.
6) Illustration of tacking features can be found in the section of Detailed Description.

8.3 Dynamic Characteristics

8.3.1 Output Voltage Deviation

Output Voltage Deviation is defined as the response of the converter to a sudden step change in the output load current. The output voltage deviation is characterized by two parameters: Maximum Output Voltage Deviation and Response Time (please refer to the data sheet for the detailed specification). The value of dynamic resistance for a defined step current is defined as:

$$R_{dynamic} = \frac{Vout}{0.5 * Imax}$$

Test

1) Turn on the fan.
2) Adjust the input voltage to the desired operating point.
3) Set the electronic or resistive load at 50% of maximum load.
4) Change channel 1 to scope probe and measure across the $R_{dynamic}$.
5) Set the switch SW2 to the converter ON.
6) Set channel 2 on the oscilloscope to be AC coupled and to 50mV/Div and for 5mS/Div. Set the trigger to auto and adjust the trigger point at a negative going pulse for step load change from 50% to 100% of Io or adjust the trigger point at positive going pulse for step load change from 100% to 50% (Please refer to data sheet for the detailed information.)
7) Measure the Peak-to-Peak deviation and capture the waveform as required.

8.3.2 Turn-On Response Time.

Turn-On Response Time is defined as the time it takes for the output to rise to within 90% of its final value from the time when the converter is enabled. The rise time is deliberately made slower to reduce the inrush current and to eliminate any overshoot in the output voltage. These test functions have two categories.

1.) Turn on the module by using the External switch to control input voltage.
2.) Turn on module by using the Enable on/off.

Note: There is some difference in the performance of each mode - please refer to the data sheet for the detailed information.

Test (Turn on the module by using the external switch)

1) Turn on the fan.
2) Turn on the input power supply and set it to the desired operating point.
3) Set channel 1 on the oscilloscope to be DC coupled and to the appropriate range for the input voltage.
4) Connect a coaxial cable from channel 1 to BNC1 on the Evaluation Board.
5) Set channel 2 on the oscilloscope to be DC coupled and to the appropriate range for the output voltage.
6) Connect a coaxial cable from channel 2 to BNC2 on the Evaluation Board.
7) Set the Time base to 2mS/Div
8) Set the Trigger for a one-time event and set the Trigger level at approximately 2V (rising) or suitable trigger point (referring to data sheet) on channel 2.
9) Enable the external on/off switch to supply power and use the cursor V Bars to measure the delay time and then record the waveform on the oscilloscope.

Test (Turn on the module by using the Enable on/off)

1. Turn on the fan.
2. Turn on the input power supply and set it to the desired operating point.
3. Set channel 1 on the oscilloscope to be DC coupled and to 1V/division. (Please also refer to data sheet for the detailed information).

4. Connect a scope probe from channel 1 between the on/off control pin and reference ground (SGND) on the Evaluation Board.
5. Set channel 2 on the oscilloscope to be DC coupled and within appropriate range for the output voltage.
6. Connect a coaxial cable from channel 2 to BNC2 on the Evaluation Board.
7. Set the Time base to 2mS/Div
8. Set the Trigger for a one-time event and set the Trigger level at approximately 2V (rising) or suitable trigger point (refer to data sheet) on channel 2.
9. Enable the on/off switch to turn on and use the cursor V Bars to measure the delay time and then record the waveform on the oscilloscope.

8.4. Thermal Characteristic

8.4.1 Efficiency

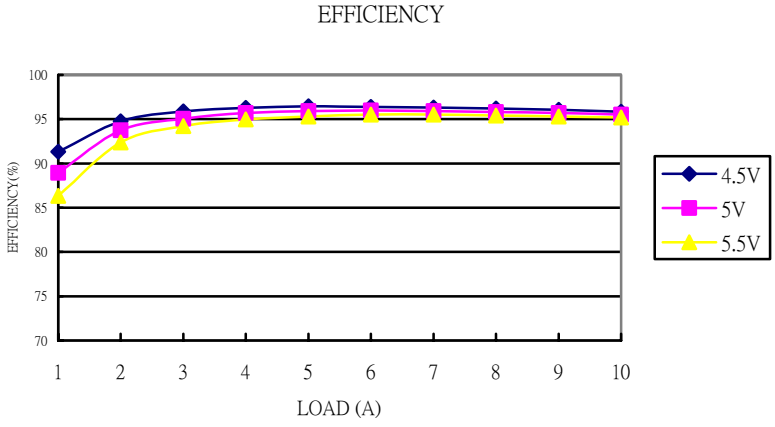
Efficiency is the ratio of total output power to the input power. It is typically measured at full load and nominal input voltage.

Test

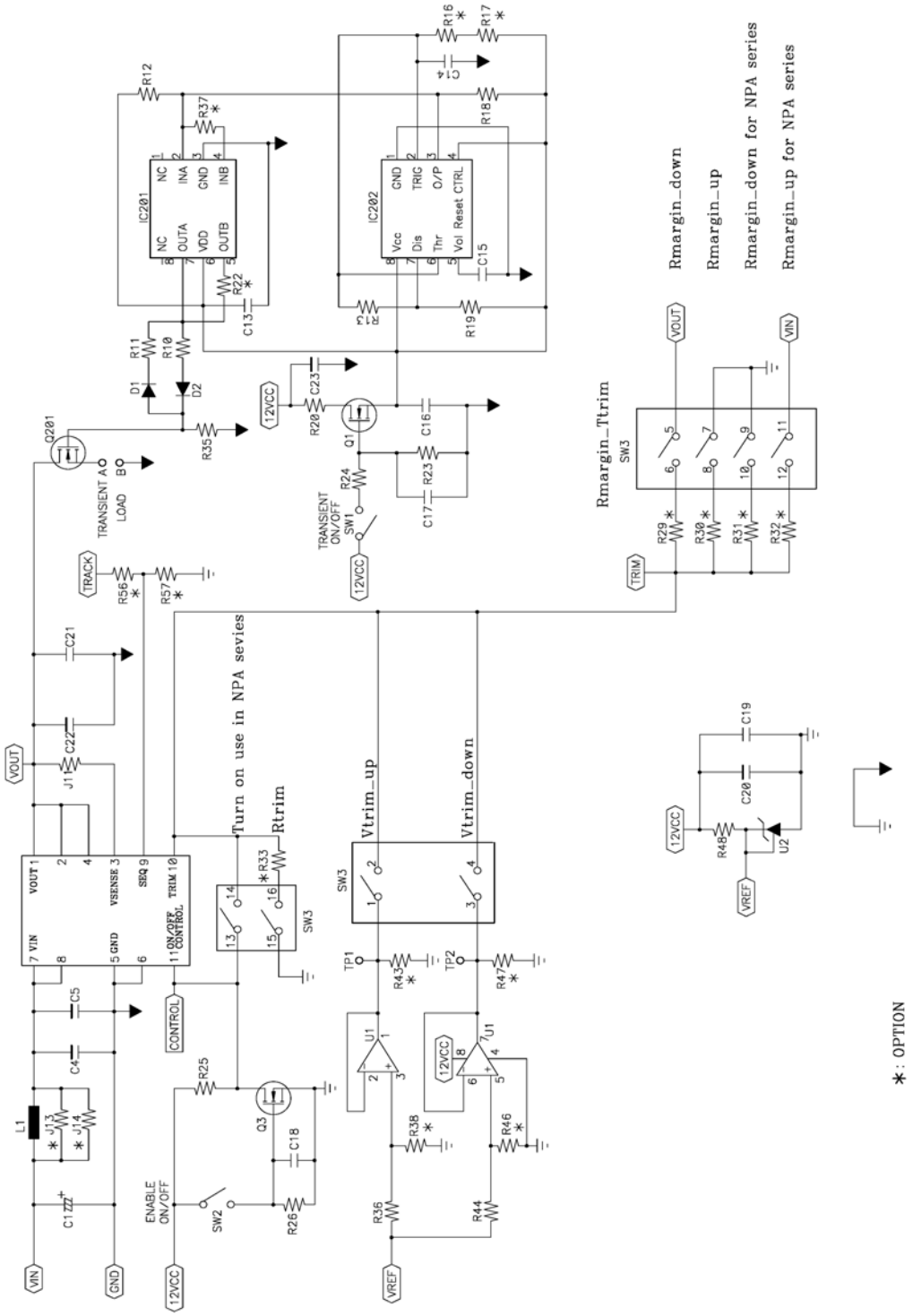
1) Turn on the fan.
2) Set the enable switch SW2 to the converter ON.
3) Adjust the input voltage to the desired operating point.
4) Set the electronic or resistive Load to the desired operating point.
5) Read and note the output voltage (DVM3) and input voltage (DVM2).
6) Read and note the input and output currents from the DVM1 and the electronic load.
7) Use the following formulas to calculate the efficiency:

Efficiency= (Pout/Pin) × 100(%)
Pin = Iin × Vin
Pout = Iout × Vout

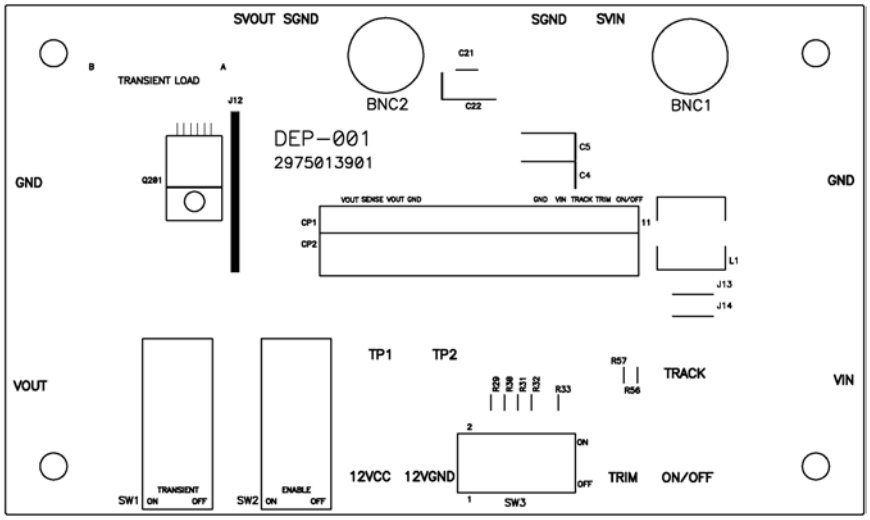
The following graph shows the efficiency curves of the DNM04S0A0R10P A module when measuring at different operating points.



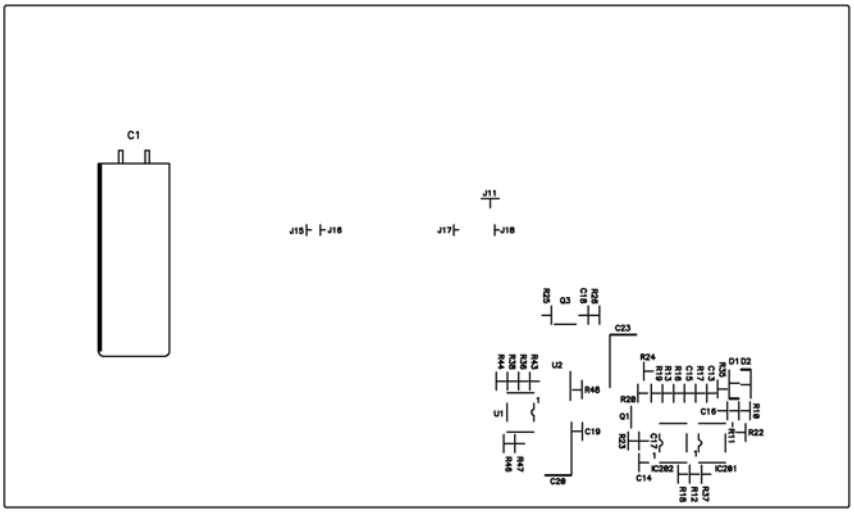
Appendix A- Evaluation Board Schematic



Appendix B - Evaluation Board Layout (Top View)



Appendix C - Evaluation Board Layout (Bottom View)



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